Quaternary Sea Ice Reconstruction: Proxy Data and Modeling

3rd Sea Ice Proxy Working Group Workshop: Sea Ice Proxy Synthesis and Data-Model Comparison; Bremerhaven, Germany, 23–25 June 2014

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The satellite-based observation of distinct contrasts between Arctic and Antarctic sea ice development provides a strong motivation to improve our knowledge of physical and biological processes governing sea ice occurrence and the role of sea ice as a polar climate amplifier. For further insight into such processes, sea ice records must be extended beyond instrumental observations.

This insight must rely on well-established sea ice proxy data obtained from marine, ice core, and coastal materials at a broad range of climate boundary conditions and at the highest possible time resolution. Ideally, proxy data information should be backed by comprehensive Earth system modeling.

A group of 31 scientists met at Bremerhaven for the third meeting of the Sea Ice Proxies Working Group (SIP3). The SIP Working Group is sponsored by the Past Global Changes (PAGES) project, and the SIP3 meeting was additionally supported by the Alfred Wegener Institute. Building on the first two SIP workshops in 2012 and 2013, SIP3 discussions focused on multiproxy compilations, sea ice data syntheses for late Quaternary time series and time slices, the state of sea ice modeling, and proxy/data comparisons.

In addition, progress in proxy development was highlighted, for example, a new proxy allowing for extension of instrumental observations of Arctic sea ice at annual resolution based on the analysis of growth increments of crustose coralline algae and the identification of the source of the biomarker IP25, making this proxy a very powerful tool for Arctic sea ice reconstruction.

New studies concerning production, transport, and deposition of aerosols (sea salt, methanesulfonic acid, and halogens) provide the background data required for the establishment of robust sea ice proxies from ice core records. Although much progress was made, SIP3 suggests that process-related studies should be further intensified to improve our understanding of mechanisms and also suggests fostering the search for additional new proxies.

The SIP3 participants concluded that sea ice estimates with large spatial coverage that records a broad range of climate conditions should rely on a combination of different proxies considering their specific applicability. The limitations, strengths, and significance of individual proxies should be tested by comparing different proxies. Arctic sea ice development has now been documented at time slices with a resolution of up to 2000 years since the Last Glacial Maximum. This resolution provides a picture of natural variability, giving a context for the recent change. Similar data, but at lower resolution, are also available for large areas of the Southern Ocean.

The workshop described Antarctic sea ice mapped at time slices across the penultimate glacial-interglacial transition with warmer than present climate conditions, which may present a template for future conditions. It was suggested that gaps in spatial and seasonal information (e.g., concerning summer sea ice) may be bridged by modeling. This, however, implies further improvement of the modeling of sea ice, as uncertainties possibly related to sea ice parameterization or applied boundary conditions remain. As such, SIP3 participants welcome stronger interaction between sea ice data production and modeling to the benefit of paleoclimate research.

For a list of participants, the agenda, and a summary report, see http://www.pages-igbp.org/workinggroups/sea-ice-proxies/intro.

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